NOTES ON THE MORPHOLOGY AND BIOLOGY OF A NEW SPECIES OF *CHALYBOSOMA* (DIPTERA, TABANIDAE).

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(Plate xiii; twenty-one Text-figures.)

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Synopsis.

Chalybosoma casuarinae, sp. nov. (Tabaninae, Diachlorini) is distinguished by its metallic blue-green colour and swollen fore tibiae. It is recorded from north Queensland to south coastal New South Wales. Larvae and pupae were found, in company with those of the stratiomyiid, *Syndipnomyia auricincta* Kert., in cavities made by a longicorn beetle, *Agrianome spinicollis* (Macq.), in the trunks of *Casuarina cunninghamiana* Miq. The larvae are like those of other Diachlorini, but the pupae have the lateral arms of the aster greatly enlarged.

Introduction.

The early stages of Tabanidae used to be thought of as mainly aquatic; but they are now known to occur in a great variety of situations, some of which are remarkably dry (English, 1955). Larvae and pupae of the Ethiopian-Oriental tribe Rhinomyzini have so far been found only in rot-holes in forest trees, an environment which may vary from wet to dry, according to season. The species to be described here appears to be the first member of the subfamily Tabaninae to be bred from this kind of habitat, although a few have been collected in rotting, fallen tree-trunks, and one in the detritus on the floor of a hollow tree (Fairchild, personal communication).

We are indebted to Dr. P. B. Carne, Division of Entomology, C.S.I.R.O., Canberra, for identifying the longicorn beetle, to Dr. S. J. Paramonov, of the same Division, for identifying bred adults of the stratiomyiid fly, to Dr. G. B. Fairchild, Gorgas Memorial Institute, Panama, for the Neotropical material discussed later in the paper, and to Mr. D. H. Wilson, C.S.I.R.O., and Dr. M. J. Mackerras for the photographs.

Habitat.

Merricumbene Creek (35° 44′ S, 149° 55′ E), where the larvae and pupae were found, is about 25 miles north-west of Moruya in south coastal New South Wales, and is the largest of several local tributaries of the Moruya River. It rises in wet sclerophyll forest at about 2,000 ft., descends abruptly between rugged spurs beneath a canopy of myrtle (*Backhousia myrtifolia* Hook. & Harv.), runs through a talus slope bearing relics of an original rain-forest flora, and then wanders out onto the cleared country of the plain, where its lower reaches are lined by a dense, almost pure belt of river oaks (*Casuarina cunninghamiana* Miq.), which form a thin, peripheral canopy over the creek bed (Plate xiii, figs. 1, 2). Both the Moruya River and Merricumbene Creek may become raging torrents after rain; but, whereas the river is permanently running, the creek quickly subsides to a chain of pools which are maintained almost permanently by subsurface drainage.

Merricumbene Creek is in a zone in which the mean temperature is over 68°F. in the hottest month and between 34° and 46°F. in the coldest, and there is no month with a mean rainfall less than 2 inches (Department of Lands, 1946). The average annual rainfall for 53 years at Araluen, 12 miles away, was 33·34 inches, with a range from 21·65 to 71·26 inches. The monthly rainfalls for the period of observation are shown below, the first nine months being for Araluen and the remainder for

Merricumbene Creek. The scanty information available suggests that the drought of 1954 may have favoured the Tabanidae by allowing the tree-holes to become relatively dry.

Monthly rainfall for Araluen and Merricumbene Creek.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1954:	148	838	11	33	9	106	76	35	120	328	261	139
1955:	211	809	286	221	1453	53	90	78	192	245	173	472

Although there are a few dense patches of young growth, the community of river oaks along lower Merricumbene Creek consists mainly of old trees, rising to more than 100 ft., and with trunks up to 5 ft. in diameter at ground level. Most of the trees showed evidence of advanced attack by larvae of a longicorn beetle, *Agrianome spinicollis* (Macq.), which produced deep cavities with small external openings. Evaporation from the cavities was slow, and seepage down the inside of the trunk often contributed to the permanency of the water in them. Many, both large and small, were observed to hold water for several months, during which there was little additional rainfall.

Larvae and pupae of *Chalybosoma casuarinae* were first collected on 1st December, 1954, from a large cavity in a living river oak standing just inside the bank of lower Merricumbene Creek. The 3 in. circular opening was 5 ft. above ground, and approximately at the same level as the top of the bank (Plate xiii, fig. 3). It faced north-east, and received direct sunlight only during the forenoon. The cavity was about 15 in. across, internally, and extended for some distance up the trunk, probably to other openings. Its contents consisted of a wet, sticky mixture of rotted grub chewings and inorganic silt. Two tabanid pupae and three larvae were found, together with numerous immature stages of *Syndipnomyia auricincta* Kertesz (Stratiomyiidae).*

The breeding medium was returned to the cavity, which was then filled to capacity with 1½ gallons of clean creek water. In January, 1955, it was occupied by larvae and pupae of a complex of *Tripteroides* spp. and *Aëdes* (*Finlaya*) spp. (Culicidae), and larvae of *Culicoides* sp. (Ceratopogonidae). These were reduced by autumn to two species of *Aëdes* (*Finlaya*), which were replaced in the winter by a pure colony of *Megarhinus speciosus* Sk. (Culicidae). Water remained in the cavity, and no further tabanid larvae or pupae were recovered up to the last inspection in April, 1956.

On 10th January, 1955, a broken pupal skin was found in the entrance to a cavity about 5 ft. from the ground in another river oak, about a hundred yards from the first. The contents of the cavity presented a dry surface layer, beneath which was a moist. but not sticky, mixture, consisting principally of rotted grub chewings, and containing larvae of *S. auricincta*.

The section of limb containing the cavity was removed on 25th November, taken to Canberra, and opened up on 6th December, 1955. The cavity was quite small, and the longicorn grubs had long since left that part of the tree. Its contents were moist, yet friable, and filled it almost to the brink of the small, perpendicularly lenticulate, external opening. Four live tabanid larvae and a dead pupa were found in the damper part of the cavity, among clumps of about 250 larvae of *S. auricincta*. One live tabanid pupa was in a narrow pocket, formed by a grub tunnel just above the entrance hole. When separated into a small jar, it orientated itself vertically beside a chip, with the abdomen down, just as it was when found. The larvae were offered a small larva of *S. auricincta*, but none fed.

Nothing is known of the habitat or behaviour of the adults, in spite of extensive study of the blood-sucking insects at Merricumbene by A.L.D. during an investigation of the epidemiology of myxomatosis. Between September, 1954, and April, 1956, the area was visited by three experienced collectors 24 times, totalling about 300 man-days, covering all seasons and a wide range of weather conditions. Human, cow, and rabbit baiting was frequently employed during daylight, dusk, and darkness; horse, dog, and fowl to a lesser extent; and pigs and sheep were watched for biting flies during the day. Collection from resting places and by light trapping (modified du Toit pattern) took place at every visit. Other adult Tabanidae were collected, but no *Ch. casuarinae.*

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* The striking, wasp-like adult of this species has been illustrated by Nicholson (1927, Plate I, Fig. 7, and Text-fig. 2D).

The arboreal canopy was not investigated, and it was not possible to bait with other local animals on which *Ch. casuarinae* might feed. Bird life was diverse and extensive, while lizards, snakes and frogs were also common, and a species of *Hyla* was often found in the tree-holes. Burrows of *Rattus rattus* (L.) were frequent in the banks of the creeks, and an occasional swamp wallaby, *Wallabia bicolor* (Desm.), was seen at dusk feeding on the flats. An association with any of these would be difficult to detect.

Stands of *Casuarina* are common in all suitable streams from north Queensland to southern New South Wales, so the distribution of *Ch. casuarinae* may well be continuous.

Behaviour in Captivity.

Of the two pupae collected on 1st December, 1954, one was preserved, and the other produced a male on 9th December. One of the larvae was accidentally killed, but the other two lived in the laboratory in individual jars until pupation took place. They were kept at first in the muddy medium in which they were found, but this was later changed to a damp wood mould from other sources. They fed readily enough, as a rule, on the soft-bodied pupae of species of *Ephestia* and *Heliothis*, but at times they refused to eat, and at other times they were left for long periods without food. It has been found that tabanid larvae can survive without food for many months.

One pupated after eleven months, and a male emerged on 29th November, 1955, after a pupal period of about twelve days. The other lived for twenty-three months before pupation took place. This pupa was kept for three weeks, but it had then become inactive and very dark, so was presumed dead and was preserved. It was another male.

The pupa separated from the second batch of material on 6th December, 1955, produced a female three days later. The larvae were much smaller than those of the first batch; they died some months later, when the medium in which they were kept was allowed to dry out too much.

Classification.

Subdivision of the Australian Tabaninae into genera and subgenera has not yet reached finality. The present arrangement may be summarized in the following key, which will serve to indicate the relationship of the new species to other local members of the subfamily.

Key to Australian Genera of Tabaninae.

1. Basicosta with dense setulae, like those on costa .... *Tabanus* Linn.
   Basicosta without strong setulae, contrasting with costa .... 2.
2. Antennae much longer than head, first segment three times as long as wide; slender, *Chrysops*-like species, with conspicuous dark brown pattern on wings .... *Lissimas* End.
   Antennae not longer than head, first segment little longer than wide; not *Chrysops*-like species .... 3.
3. Metallic blue-green, calliphorid-like species, with subcallus, parafacials and face rather bare and shining .... *Chalybosoma* Oldr.
   Not metallic blue or green species; face, parafacials, and usually subcallus, tomentose .. 4.
4. R_4 with appendix; eyes hairy, at least on upper facets of ♂; frons of ♀ wide, index usually less than 3; usually broader, more hairy species .... *Dasybasis* Macq.
   R_4 without appendix; eyes bare in both sexes; frons of ♀ relatively narrow, index usually more than 4; usually slimmer, smoother species .... *Cydistomyia* Tayl.

One small group of species, with hairy eyes and no appendix to R_4, is omitted from the key; it may belong to the New Zealand subgenus *Dasybasis* (*Protodasyommia*).

The genus *Chalybosoma* (type *metallicum* (Ric.)) was established by Oldroyd (1949) for three Papuan species. It is proposed now to add the Australian *Ch. cyanea* (Wied.) and *Ch. casuarinae*, sp. nov., to it. The Papuan species stand rather apart from the other two, and the group may not be strictly monophyletic, but it is convenient to treat it, for the present, as a single, northern element independent of the typically Australian *Dasybasis* and *Cydistomyia*.

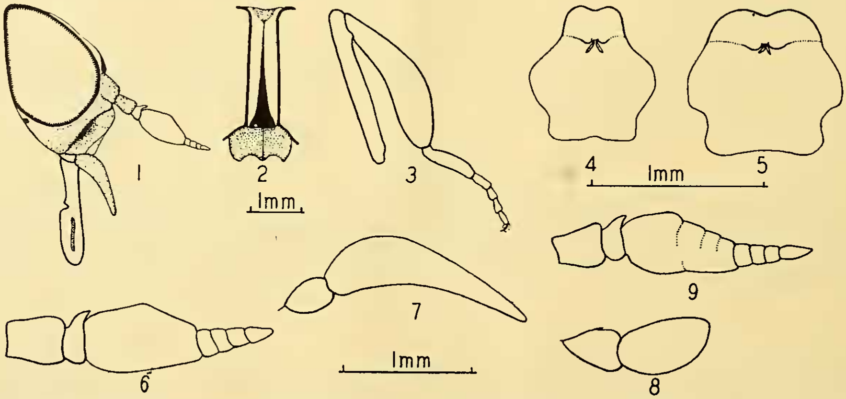
CHALYBOSOMA CASUARINAE, sp. nov.

Types: Holotype ♀ and allotype ♂, bred from pupae, Merricumbene, New South Wales, A.L.D., the ♂ emerged 9.xii.1954, the ♀ 10.xii.1955, in the Division of Entomology, C.S.I.R.O., Canberra, A.C.T. Both have the pupal skin attached. Morphotype larva and cleared preparations of larva and larval exuvia in the same collection.

Female.

A thick-set species, distinguished from all other Australian Tabanidae by the combination of dark metallic blue-green colour, black antennae, swollen tibiae, and spotted wings. *Ch. cyanea* is also metallic blue-green in colour, but has differently shaped, bright orange third antennal segment, less swollen tibiae, and clear wings. Length: 10–12·5 mm.

Head (Text-figs. 1, 2). Eyes in life dark metallic green, unbanded; with short sparse hairs, just visible by tangential illumination at ×15. Frons medium (index 4–4·5), parallel or slightly diverging, covered with thick silvery white tomentum, through which the dark ground colour shines at certain angles; hairs black, short, inconspicuous; vertexal triangle prominent, somewhat swollen, shining dark blue, with black hairs; a single puncture at its anterior angle, but no ocellar tubercle; callus greenish-black, shining, lower part somewhat swollen and wrinkled. Subcallus rather prominent, shining blackish-brown, with a faint tomentose overlay; parafacials dark brown, somewhat shining, with black hairs; face more definitely shining, with some thin white tomentum in middle below antennae, and with black hairs; tentorial pits large, deep and prominent. Antennae: first segment shining blue-black, with black hairs; second black, with black hairs; third dull blackish-brown, of unusual shape (Text-fig. 6), style short. Palpi shining blue-black, with black hairs. Beard black.



Text-figures 1-9: *Chalybosoma casuarinae*, sp. nov., adults.—1, head of female; 2, frons of female; 3, fore leg of female; 4, eighth sternite of female; 5, the same of *Ch. cyanea* (Wied.) for comparison; 6, 7, antenna and palp of holotype female; 8, palp of male; 9, antenna of female from Imbil, Q., for comparison with 6.

Thorax. Scutum and scutellum metallic dark blue-green, with thin ashy dusting and indications of a median line anteriorly, more purplish blue laterally; hairs black. Pleurae somewhat shining bluish to brownish black, with black hairs.

Legs. Black, with dark purple reflections, except for cream fore knees and more brownish mid and hind knees; hairs black, except for a pale antero-ventral zone on fore tibiae and reddish-brown ventrally on tarsi; pulvilli cream, prominent. The fore tibiae are markedly swollen (Text-fig. 3), and the mid and hind less so.

Wings. Clear over most of membrane; stigma blackish; veins dark brown. There are the following conspicuous dark brown marks (Plate xiii, fig. 4): one filling cells at extreme base of wing, and extending a little into basal cells; a small one on Rs just beyond fork of R; a transverse band covering the apices of the basal cells; one extending from costa through the stigma and R_{2+3} (which is curiously sinuous) to reach R_{4+5}; and five small spots apically and posteriorly, at the tip of R_{2+3}, at the tip of R_4, at the fork of R_{4+5}, at the fork of M_{1+2}, and at the tip of Cu_1+1A. Vein R_4 angulate, with a rudimentary appendix. Basicosta bare.

Abdomen. Dark metallic bluish-green above and almost blue-black below, with a brownish hue at lateral edges of first and second tergites in the older specimens; hairs entirely black. Genitalia: 8th sternite of somewhat unusual shape (Text-fig. 4); otherwise not distinctive.

The ♀ from Kuranda agrees with the type, except that the band at the apices of the basal cells is connected by a bar of pigment with the spot at the tip of Cu_1 The ♀ from Imbil has differently shaped antennae (Text-fig. 9), and slightly less swollen tibiae. It is not possible to assess the status of these forms without more material.

Male.

Similar to ♀. Eyes with upper facets distinctly enlarged, bright orange with yellow reflections; lower and posterior small facets rich blue, with a purple zone at margin of upper facets; hairs more evident than in ♀, especially on upper facets. Antennae more slender; palpi (Text-fig. 8) short, acorn-shaped. The swelling of the tibiae may be slightly less than in the ♀, and the hind tibial fringes better defined. Genitalia without distinctive characters.

Larva.

The larva is creamy white, with transparent, longitudinally striate skin; it is more or less cylindrical, tapering anteriorly to the small head (Text-fig. 10), and abruptly truncate at the posterior end (Text-fig. 11); there is no siphon. A living, full-grown larva measured about 15 mm. long by 5 mm. broad when contracted, and extended up to about 25 mm. long when moving. Larvae of *Ch. casuarinae* may be distinguished from those of *Dasybasis oraria* (Eng.) by having a narrower collar of hirsute skin round the spiracular mound, no fringe round the spiracle, and the abdominal prolegs armed with very numerous minute but strong spines instead of small patches of hirsute skin only. The last character appears to be a good one, but can be seen only in cleared preparations examined at × 200 or more.

The terminology of Cameron (1934) is used for the structures of the head of the larva and the chaetotaxy of the head and thorax of the pupa.

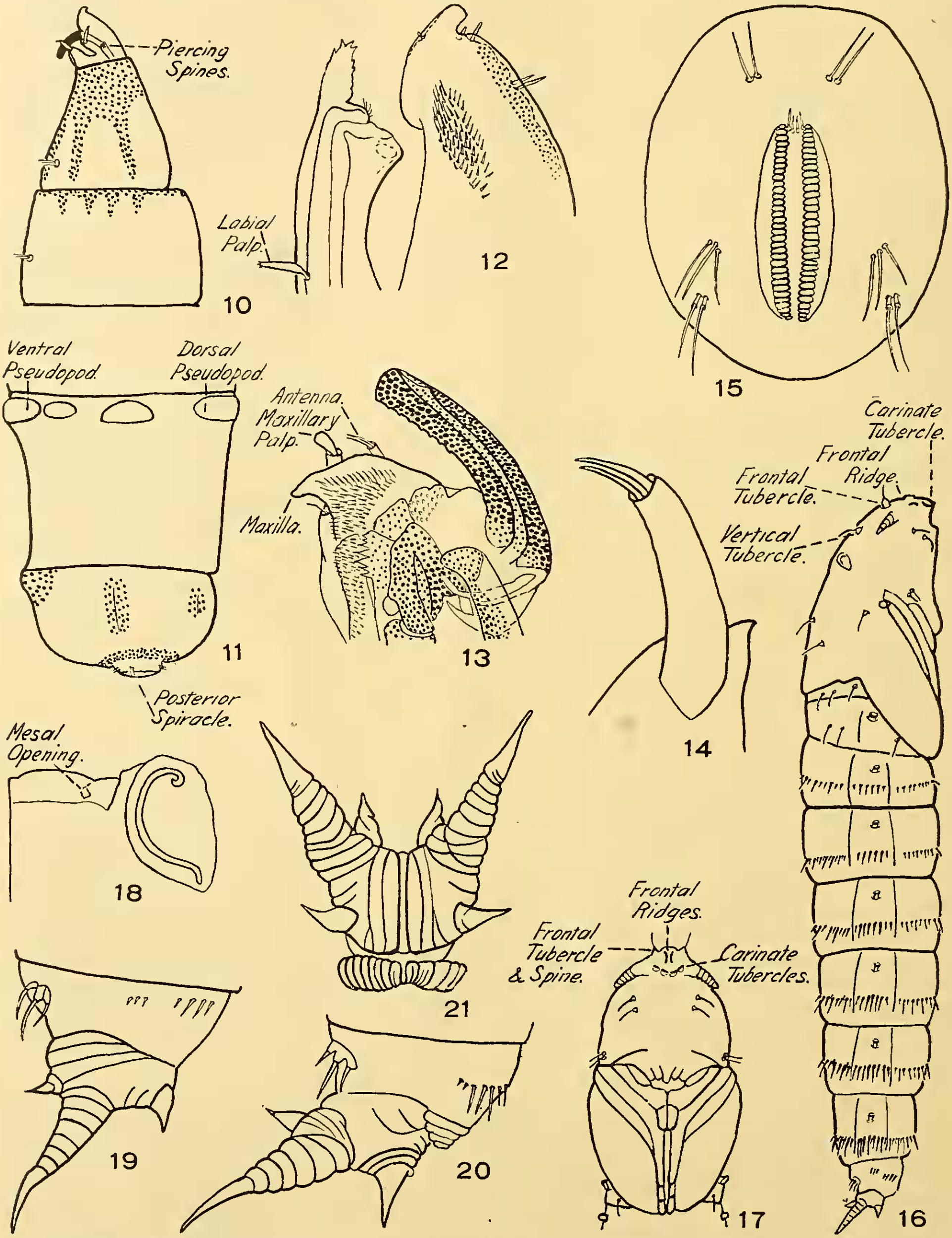
Head. The clypeus (Text-fig. 12) is large, laterally compressed, with a small, upturned labrum at its distal end; there is a longitudinal groove, bearing some sensory hairs, on its dorsal edge, a band of heavier, darker chitin below the groove, and a patch of hairs or spines below this on each side. The labium lies below the clypeus, terminates in paired, sharply toothed glossae, and bears the labial palpi posteriorly. The heavily chitinized, curved mandibles (Text-fig. 13) have the characteristic longitudinal canal and serrated lower edge. The maxillae are broad at the base, and terminate in a short, narrow, downwardly projecting tip; they are covered with hairs or setae, except for a bare anterior border; the maxillary palpi are thick. The antennae (Text-fig. 14) are two-segmented, and set on a flattened cephalic sclerite; the apical segment is bifid, with one branch slightly shorter and more slender than the other. There is a group of piercing spines between the base of the antennal sclerite and the clypeus.

Thorax and *abdomen* (Text-figs. 10–11). The annulus of the prothorax is pale brown, and densely covered with very minute spines. Hirsute skin occurs also on small areas on the thorax and abdomen, with a similar distribution to that described by Fuller (1937) for *Dasybasis froggatti* (Ric.) and *D. gentilis* (Erich.), and by English (1949) for *D. oraria.* The prolegs of the abdomen bear strong spines, and there is an irregular band of hirsute skin in front of each circlet of prolegs. The posterior spiracle has the typical tabanid form, and there are groups of flexible hairs, some visible at × 10, on the spiracular mound (Text-fig. 15).

Pupa.

The pupa is about 19 mm. long and 4 to 4·5 mm. wide on the thorax. It can be distinguished from the other known pupae of Australian Tabaninae by the form and arrangement of the setae on the abdominal tergites, and the large lateral arms of the aster.

Head and *thorax* (Text-figs. 16–17). The head has prominent carinate tubercles, low frontal ridges, and the following setae on each side: one frontal on a prominent



Text-figures 10-21: *Chalybosoma casuarinae*, sp. nov., larvae and pupae.—10-15, Larva: 10, anterior end, lateral view, × 12 approx.; 11, posterior end, lateral view, × 12 approx.; 12, part of clypeus, showing labrum and labium, × 70 approx.; 13, mandible and maxilla, × 70 approx.; 14, antenna, × 200 approx.; 15, posterior spiracle and setae on spiracular area, × 80 approx. 16-21, Pupa: 16, lateral view, × 5 approx.; 17, anterior end, ventral view, × 5 approx.; 18, thoracic spiracle, × 20 approx.; 19, posterior end of ♀, lateral view, × 20 approx.; 20, posterior end of ♂, lateral view, × 20 approx.; 21, posterior end of ♂, end view, × 20 approx.

tubercle, one vertical on a small but distinct tubercle, one anterior and one posterior orbital on very small tubercles, and two lateral orbitals on very small tubercles set close together. The thorax has long, slender, basal-alar, anterior mesonotal and posterior mesonotal setae on small tubercles, and three fine setae on each side of the metathorax. The thoracic spiracles (Text-fig. 18) are prominent, with large, ear-shaped rimae.

Abdomen (Text-fig. 16). The first tergite has four long, slender spines. The second has six long, stout spines arranged at intervals in a row of short spines. The long spines become longer, and some of the short spines increase in length, on the succeeding tergites, the seventh having six very long, strong spines interspersed with a variable number of shorter and very short spines. The spines are in a single row, at least on tergites 2 to 5, and this, together with their stout build and short terminal bristle, seems to provide a good distinction from the known pupae of *Dasybasis*.

There is a single long pleural spine on the first segment, four long and some short pleural spines on the second, increasing posteriorly, until the seventh has seven or eight very long, strong spines and some short ones. There are seven prominent abdominal spiracles, each with a distinct elongated rima.

The long spines on the sternites increase in number posteriorly, like those on the tergites, there being two long spines near the centre of a row of short ones on the second sternite, and 14 long, slender spines and some short ones on the seventh; the two or three central long spines on the seventh sternite are stouter than the others.

The eighth segment (Text-figs. 19–21) has a short median dorsal spine, and a dorso-lateral comb of two to four spines, but usually of three, with the middle spine longer than the others. In the ♀ (Text-fig. 19), the ventral, preanal fringe consists of eight or nine short spines with a space in the centre, and there is a small lateral comb of three or four very short spines. In the ♂ (Text-fig. 20), the preanal fringe consists of a continuous row of about 10, mostly long, spines, and there is no lateral comb. The aster consists of two large lateral arms, a very small dorsal pair, and a slightly larger ventral pair. In the type specimens, the ventral arms are slightly larger and the lateral arms more divergent in the ♂ (Text-fig. 21) than in the ♀.

Distribution.—Queensland: Kuranda, A. P. Dodd (1♀); Imbil, Feb., F. A. Perkins (1♀). New South Wales: Merricumbene, bred, Nov.-Dec., Dyce (2 ♂♂, 1 ♀).

Discussion.

A comparison of adults leaves little doubt that *Ch. casuarinae* is closely related to *Ch. cyanea*, and correctly placed in the Diachlorini. Moreover, it is remarkably like the tropical American *Selasoma tibiale* (Wied.), which also belongs to this tribe. The early stages of *Ch. cyanea* and *S. tibiale* are not known; but a study of the available pupae also suggests a tropical American relationship, this time with *Leucotabanus flavinotum* (Kröb.), a species that has usually been placed in the Tabanini.

The pupae of *Ch. casuarinae* and *L. flavinotum* resemble one another in abdominal chaetotaxy and form of the aster, and they differ from the known pupae of *Dasybasis* in both characters. Preliminary studies by K.M.I.E. indicate that pupal chaetotaxy may help in defining relationships, although the effect of habitat has not yet been fully assessed. It is to be noted, therefore, as a reservation, that Dr. Fairchild found the larvae and pupae of *L. flavinotum* in the rather dry detritus on the floor of a hollow tree occupied by bats, a habitat which is not dissimilar to that of *Ch. casuarinae*. Enlargement of the lateral arms of the aster, on the other hand, cannot be associated with either relationship or habitat, for it appears to be general in Scionini and Rhinomyzini, which are not closely related to each other, and have quite different breeding habits, while Neave (1915) recorded it in one species of *Haematopota* and several normally aquatic species of *Tabanus* in Africa.

The only useful feature so far found in the larvae is that nearly all the known larvae of Tabanini have the eighth abdominal segment prolonged into a siphon, whereas those of Diachlorini (except *Lepiselaga*) have it truncate. The larvae of *L. flavinotum* have a truncate eighth segment, which raises a doubt whether the species is correctly assigned to the Tabanini, in spite of the presence of setulae on the basicosta of the adult.

The evidence is obviously incomplete, but the general inference suggested by it is that *Chalybosoma* may not have been derived from the dominant, southern diachlorine stock of Australia, but represents a separate, tropical intrusion from the north. That is why we feel that it is more logical, at the present time, to treat it as a separate genus than to reduce it to subgeneric status in *Cydistomyia*, where we had at first been inclined to place it.

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EXPLANATION OF PLATE XIII.

1.—General view of Merricumbene Creek. The arrow points to the tree shown in Fig. 3. 2.—Bed of the creek, showing canopy of *Casuarina cunninghamiana.* 3.—Tree-hole in which larvae and pupae of *Chalybosoma casurinae* were found. 4.—Wing of *Ch. casuarinae* (♀ from Imbil, Q.).